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## CLEAN MILK AND PUBLIC HEALTH

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Behind its veil of opaque whiteness, every quart of milk hides a potential peril to the public health. To the unaided senses, unwholesome or dangerous milk may present exactly the same appearance as the purest and safest supply obtainable. Until the horizon of intelligence and imagination has been extended by science, therefore, it is exceedingly difficult to appreciate the serious need for being constantly on guard against a menace so intangible and so insidious.

Even before bacteriological and chemical research had disclosed the hidden causes of disease, milk was known to constitute a very important danger to health, and crude methods of improving the "keeping" qualities of milk by heating and refrigerating had been developed. The rapid growth of cities, however, and the consequent ever-increasing separation of the dairy farms where milk is produced from a vast number of the homes where it is consumed, has introduced a new and very serious difficulty into the problem of providing city consumers with a safe milk supply. Whereas, formerly, it was possible to distribute milk to consumers within a few hours after it was drawn, it is now frequently necessary to transport a supply from very great distances and thus separate by twenty-four, thirty-six, or even forty-eight hours the time when milk is drawn, from the time when it is delivered to consumers. When we reflect that milk is probably the most generally used article of food; that it furnishes an almost ideal culture medium for very many forms of disease germs; that it may very easily become infected at any one of the many stages of its progress from cow to consumer; and that, at favorable temperatures, the number of disease germs it contains will increase with almost incredible rapidity, the significance of the time element, as well as of care in handling milk, will at once be apparent.

With the growth of scientific knowledge regarding specific

dangers from infected milk, and with the increasing difficulty of obtaining a safe supply, there has come a more intelligent appreciation, on the part of laymen and of health officials, of the need for a comprehensive and effective plan for controlling a community's milk supply, especially in the case of large cities. There is probably no factor in a public health program that is being more actively and more persistently studied or that gives promise of more immediate and more positive results. Clean water, clean air, clean food, clean streets, clean houses, clean clothing, and clean bodies are the indispensable elements in modern preventive hygiene; and among these, if we measure importance by the potential effect upon disease and death rate, clean milk must be assigned high, if not first, rank.

Careful estimates place the average annual consumption of milk in the cities of the United States at twenty-three gallons per capita, some authorities estimating the quantity as high as one-eighth of the entire food consumption of the urban and suburban population. On this basis alone, the importance to the public health of protecting the milk supply from contamination and deterioration needs no argument. In view of the further fact that milk forms the chief and, in many cases, the sole element in the diet of the sick, the aged, and the infant members of society, the necessity for precautionary measures receives further emphasis. The technical difficulty of testing milk as to adulteration and infection, the great distances and varied sources from which city supplies are obtained, and the large cost involved, make it wholly impracticable for individual consumers to discover by direct investigation the quality of milk served by dealers. It is clear, therefore, that for reasons of economy and efficiency of service, the inspection and regulation of a community's milk supply is properly a community function, to be performed by a governmental agency having adequate legal powers, and the organization and administrative methods necessary to make its powers effective.

Stated in the simplest terms, the control of a milk supply has two main aspects, the first having to do with chemical constituents which is related chiefly to the food or nutritive value of milk; the second with bacteriological content, which is related chiefly to the pathological or hygienic effects.

On the side of chemical content, a few simple and well-defined standards concerning adulteration and the use of preservatives have been clearly established, though not even these have been everywhere accepted as a basis for practical control. It is known that the use of preservatives is both unnecessary and harmful. It is unnecessary, because milk produced under proper conditions and handled with care will "keep" long enough to permit of transportation and distribution within necessary and reasonable limits of time. It is harmful, because the addition of salicylic acid, formaldehyde, benzoic acid and other chemicals used as preservatives either impair the digestibility of milk or injure the digestive organs of the consumer, especially in the case of young infants, whose membranes are extremely sensitive to such irritants. Although the use of such preservatives is prohibited by the national pure food law of 1906, and by the laws of many States, there is still a wide sale for these chemicals under such trade names as "Iceline" and "Freezine." It is not uncommon, especially in the summer, for a dairyman to add one of these preservatives; the wholesale dealer, in ignorance of this fact, adding a second treatment; and the retail dealer, again in ignorance of what has been done, adding a third preservative to the same milk. Such practice is, of course, little short of criminal. It can be detected only by chemical tests and can be prevented only by constant inspection and vigorous prosecution of offenders.

Adulteration is still practiced to a very considerable extent, the most common methods being the addition of water or skimmed milk and the removal of cream. The addition of chalk and other materials for thickening and coloring milk is probably practiced to a very limited extent. Adulteration of any kind, without the knowledge of the consumer, is unwarranted and fraudulent. The addition of water not only alters the nutritive value of the milk, but is often a source of pollution; the introduction, even in minute quantities, of water infected with typhoid or other water-borne germs being sufficient to start a widespread epidemic. The removal of cream materially affects the food value of milk and in this way may result in serious consequences to infants and others dependent upon a milk diet.

Gross adulteration is readily tested either by chemical or by physical (lactometer) tests. Inasmuch as milk varies considerably in the relative amount of water and of solid contents which it normally contains, however, it is impossible, within certain limits, to determine by inspection whether or not water has been added. The usual method of controlling water adulteration is to fix a minimum standard of solid contents and to exclude or destroy milk not conforming to this standard. It is readily seen, however, that milk containing milk solids in excess of the standard may be manipulated by adulteration or by removal of cream so long as the legal standard is maintained.

It is a common error to assume that milk found to meet a legal standard as to solid contents may thereby be known as milk of high quality. As a matter of fact, when milk just reaches the usual legal standards, it is *prima facie* inferior in quality, being of the lowest grade permitted. There has been a tendency, recently, to lower legal standards so that milk from certain breeds of cow, notably the Holstein, which is normally deficient in milk solids, might come within the prescribed limits. Such legislation might be characterized as itself a species of adulteration, placing, as it does, a premium upon low-grade milk and making it possible for an unscrupulous dealer to impair the food value of milk normally good, by the addition of water or the removal of cream, without making himself liable under the law.

It is true that the minimum limit must not be placed so high as to exclude the milk from too many herds. Aside from the danger of infection, however, there seems to be little difference between adding water after milking, by means of a dipper, or before milking, through the natural processes of secretion. The rational remedy for this difficulty appears to be the grading of milk on the basis of its food value and the fixing of prices for the several grades, so that both dealers and consumers may reap the advantage of maintaining high standards. Such a plan requires that consumers be so educated as to appreciate the difference between high-grade and low-grade milk, and to demand satisfactory evidence as to the quality of milk received.

The second main aspect of the problem of controlling a milk supply has to do with the bacteriological content of milk, which

is the side of the problem most intimately related to the public health.

Next to polluted water, there is probably no more prolific source of infectious disease than contaminated milk. The danger from infected water has been widely recognized and methods of protection by filtration and by other means have been so thoroughly studied and so well developed that many communities have practically eliminated water-borne epidemics. In such communities, as well as in those where typhoid is still distributed through the water pipes, polluted milk continues, without effective check, to play its part in causing periodic epidemics of typhoid, scarlet fever, diphtheria, diarrhea and other infectious diseases.

In a recent bulletin (No. 56), the Public Health and Marine-Hospital Service of the United States gives a tabular summary of 500 epidemics in which there is conclusive evidence that milk was the carrier of typhoid, scarlet fever, diphtheria and septic sore throat. In each case the circumstances of the outbreak are described, together with the evidence that milk was the source of the disease, the manner in which the milk was infected, the number of persons affected, the number of deaths, and the number of persons supplied with milk from the dairy to which the disease was traced.

The facts presented in this summary show that a typical milk epidemic is explosive in its outbreak, the infection being carried to all users of a given supply at practically the same time, thus causing a relatively large number of them to develop the disease simultaneously. The disease in such cases follows a milk route so closely that a map of the route may frequently be outlined by merely charting the cases of the disease as they are reported. It is found that the homes of the well-to-do are often attacked in greater proportion than others, owing to the fact that families with larger incomes commonly drink more milk than those with smaller resources; the latter using milk mainly in tea or coffee and in food preparations that are cooked. Similarly, it is thought that women and children, being larger consumers of milk than men, are more frequently affected by milk-borne epidemics. The 500 milk epidemics described in these tables are only a few of those concerning which definite records

are available. The immense number for which such records are not available can only be surmised.

The precise relation of milk to the spread of tuberculosis has been a matter of uncertainty. The announcement made by Koch, about ten years ago, that bovine tuberculosis is very slightly, if at all, transmissible to human beings, seemed at the time to dispose of a very serious problem. Subsequent investigation by a large number of observers, however, has removed all doubt as to the fact of transmission of the disease from cows to human beings. One of the most active of these observers, von Behring, goes so far as to state that the use of cow's milk as food for infants is the principal cause of human tuberculosis. More conservative authorities estimate the percentage of the disease in man due to bovine origin as low as three per cent. Taken with the fact that not less than 160,000 deaths from tuberculosis occur annually in the United States, even this low estimate shows that cow's milk infected with tuberculosis presents a very grave menace to the public health.

There is no doubt that, among children under five years of age, bovine tuberculosis is relatively a much larger cause of the disease than among adults. Recent observations in two institutions for the care of children in New York strongly support the conclusion that about one-half of those children who develop tuberculosis and who are fed upon raw cow's milk contract the disease from infected milk. Since about one in fourteen deaths from tuberculosis in the United States, for the year 1905, were among children under five years old, it is probable that 6000 deaths among these children were chargeable directly to infected milk. The number contracting the disease within this age period and dying later cannot, of course, be given, but must be very large.

Reliable facts concerning the prevalence of tuberculosis among herds are difficult to obtain. Apparently the number varies greatly with climate, location, and the care given to the cows. In certain districts, autopsies show as high as 60 per cent. of the cattle to be tuberculous; in others the number is so low as to be almost negligible. Taking the country at large, it seems likely that not less than one in three of the dairy herds and not less than one in five of all dairy cows are tuberculous. Considering the fact that milk from a single tuberculous cow

may be mixed with and thus contaminate the milk from a large number of cows not affected, and that tubercle bacilli contained in the feces of infected cattle may contaminate milk from non-tuberculous cows, the spread of tuberculosis through a milk supply is seen to be a matter calling for vigorous and constant action.

Important as it undoubtedly is to safeguard the milk supply of a community as a means of controlling the ravages of typhoid, scarlet fever, diphtheria and tuberculosis, it is even more important as a means of reducing the enormous mortality among infants which is chargeable in very large measure to gastro-enteritis (diarrhea), the dominant cause of which is unclean milk and ignorant feeding.

The number of deaths among infants under one year old in the United States, for the year 1909, was approximately 250,000, which is about one-fifth of the total number of deaths of all ages. Of this startling number of infant deaths, it is estimated that almost two-thirds were preventable; at least one-quarter being caused by enteritis alone—a shocking sacrifice to ignorance and carelessness.

The stupendous proportions of this annual waste of infant life will be more clearly appreciated when it is compared with the 160,000 annual deaths from tuberculosis and the 20,000 from typhoid, which are the occasion of such general agitation. The infant deaths from enteritis alone—attributable almost wholly to milk infection—were about three times as numerous as the deaths of all ages from typhoid, which is itself very largely a milk-borne disease.

In an article appearing in the *American Journal of Medical Science* (Vol. CXXXII, pp. 811-835), Harrington gives the following statement regarding the infantile death rate per thousand infants in the States constituting the registration area of this country. The figures are based upon the report of the Bureau of the Census for 1900.

District of Columbia .....	274.5	New York .....	159.8
Rhode Island .....	197.9	Connecticut .....	156.8
Massachusetts .....	177.5	Maine .....	144.1
New Hampshire .....	172.0	Vermont .....	122.1
New Jersey .....	167.4	Michigan .....	121.1

The cities show an even higher infant mortality rate. One hundred and six towns and cities had a rate of 175 or more per thousand, nine of these having a rate exceeding 300 per thousand; the highest rate, that of Charleston, S. C., being 419 per thousand. Eight of the largest cities had infant mortality rates as follows:

Washington, D. C. ....	274.5	Brooklyn, N. Y. ....	197.2
Baltimore, Md. ....	235.1	Boston, Mass. ....	194.1
New Orleans, La. ....	229.2	Borough of Manhattan ....	190.9
Philadelphia, Pa. ....	197.2	New York, N. Y. ....	189.4

In a chapter on "Infant Feeding," in the bulletin before cited, Dr. Schereschewsky quotes records showing that in France, during the five-year period 1892-1897, 385 infant deaths in every 1000 were due to gastro-intestinal diseases; the death rate from this cause in certain cities running as high as 700 per thousand infant deaths. Records are given for 42 German cities, also, showing infantile death rates ranging from 127 to 271 per thousand births, the average for the forty-two cities being 198. The per cent. of these deaths due to diarrhea varied from seventeen to fifty-four per cent, the average being forty-four per cent. These figures are interesting as showing the relative mortality in American cities and as confirming the conclusion that a great proportion of infant deaths are due to the single preventable cause of diarrhea.

The fact that the number of deaths from diarrhea invariably increases enormously during the summer months, when it is most difficult to prevent the multiplication of bacilli in milk, is further evidence of the need for more effective control over milk infection. Schereschewsky states that in the city of Leipzig, whose percentage (54.9) of deaths from diarrhea is the highest among the German cities, the infant mortality in February was 131 per thousand, of which thirty-seven were from diarrheal diseases. In August the infant death rate had increased to 570, of which 430 (75.6 per cent.) were from enteritis. It is a general observation that the great wave of infant mortality during the summer months is accounted for almost wholly by the increase in intestinal diseases.

The part played by infected milk in this summer mortality  
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is strikingly shown by the contrast between the death rate among breast-fed and that among artificially fed babies. Planchon (quoted by Schereschewsky) shows that while the diarrheal death rate of breast-fed infants in Paris varies from a minimum of two per thousand in winter to a maximum of twenty per thousand during the summer, the rate for artificially fed infants varies from twelve per thousand in winter to 158 in summer. Harrington's figures, for a five-year period in Berlin, show similarly that, in cases where the mode of feeding was known, about ninety per cent. of infant deaths were among artificially fed babies, and ten per cent among the breast-fed.

Such figures as are available for American cities fully confirm the great disadvantage of artificial feeding. In a recent paper presented at a conference called by the New York Milk Committee, for example, Dr. William H. Park gave the following observations as to the effect of different types of feeding upon infant mortality and morbidity:

Kind of Feeding	Observed	Number of Infants	
		Died	Sick
Cheap store milk—heated .....	79	15	20
Condensed milk .....	70	14	14
Good bottled milk .....	98	9	29
Good milk—modified and bottled .....	145	4	24
Certified milk .....	12	0	0
Breast milk .....	31	0	7

Figures might easily be multiplied to emphasize the advantage of breast feeding. The fact remains, however, that the increasing number of women entering industrial pursuits, and other influences incident to modern urban life, are causing a distinct decline in the practice of breast feeding. Deplorable as this tendency may be conceded to be, it is not likely to be checked so long as economic forces continue to operate as at present. The problem of preventing the great annual needless mortality among infants is, therefore, a problem of providing cow's milk free from infection and from injurious preservatives, and of educating mothers and caretakers to prepare and administer such milk in a manner suited to the nutritive requirements of infants.

The chief sources of contamination to be considered in formulating and carrying into effect a program for safeguarding a community's milk supply are: First, human beings having infectious

diseases and those carrying infection on their persons; second, diseased cattle; third, polluted water; and fourth, bacteria-laden dust and dirt.

It is obvious that no person affected with typhoid, tuberculosis, scarlet fever or other infectious diseases, or who has contact with persons so affected, can handle milk or vessels to be used as milk containers without subjecting the milk to serious danger of contamination. It is not so commonly understood, however, that convalescents and persons who have apparently recovered entirely from certain diseases may continue to discharge bacilli for weeks, for years, and even for the whole of their lives. Notably in the case of typhoid, persons who have been in contact with the sick or with bacillus carriers may become centers of typhoid infection without themselves developing the disease. It has been estimated that there are about as many typhoid carriers at any given time as there are actual cases of typhoid. When to these are added the individuals in the early stages of the disease, who may continue to handle milk so long as they are physically able to do so, and others who may handle milk throughout the entire course of a mild form of the disease, it will be seen that there is reason for the utmost vigilance in this direction.

Of the diseases of cattle which render milk unfit for human consumption, tuberculosis is undoubtedly the most important, as well as the most prevalent. Where the cow's udder is tuberculous, the danger of infection through the milk is generally recognized by students of the subject. It appears to have been clearly proven, also, that the tubercle bacillus is sometimes found in the milk of cows whose udders are not specifically involved, especially where the disease has reached an advanced stage, but also in cases where the disease can be diagnosed only by means of the tuberculin test. As the milk from an entire herd is commonly mixed for transportation, it is clear that the presence of a few tuberculous cows in a herd may infect the entire product and render it unsafe for consumption.

Cows affected with gastro-enteritis, garget, cowpox, ulcers, and other septic or febrile conditions frequently produce milk infected with pus-producing bacilli, certain of which are known to cause enteritis. Moreover, even when no active pathogenic

organisms are found in milk, poisonous properties resulting from disease and from unwholesome food and water may be present in sufficient quantity to constitute real danger to persons taking such milk.

Polluted water, even where it is not used as an adulterant, is a frequent source of milk contamination. Wells and streams are often so located that the drainage from barn yard or privy vault readily finds its way into them. Decaying animal matter and excreta from patients having typhoid and other infectious diseases are often disposed of in such a way as to subject the water to contamination. Milk pails, cans, bottles and dairy equipment of other kinds, when washed with water so polluted, unless afterwards sterilized with boiling water or steam, may become the means of infecting the entire product of a dairy farm.

At every step in the handling of milk, from the cow to the consumer, there is constant danger of infection from dust and dirt. Hair and dirt from the cow's flanks and udder; manure and dust from the floor, walls and ceiling of the stable or milk-house; minute particles from the hands and clothing of the milker or handler of milk; disease-ladened dirt and filth on every hand, in dairy, milk shop, milk wagon, kitchen and refrigerator—all these contain the virulent seeds that need only be scattered by air or water or flies or the hand of man to produce a certain harvest of misery, disease and death. Modern aseptic surgery has taught the world the vital meaning of absolute cleanliness. The lesson is directly applicable to the problem of obtaining an adequate supply of clean milk. When we come to apply scientific method to the study and control of milk infection with the same intelligence and thoroughness that have been shown in surgical practice, we shall eliminate quite as much needless suffering and waste of human life as was done away with forty years ago, when the old skull-and-cross-bones surgery came to a sudden end.

Meantime, our septic method of producing and handling milk may be expected to continue until producers, distributors and consumers are ready to face the facts and, at whatever cost, to support the practical measures necessary to produce clean milk at the dairy farm and to keep it clean all the way to the consumer. A comprehensive program of this kind will involve

the isolation and often the sacrifice of diseased cattle. It will mean effective inspection of cattle, milk handlers, barn yard, water supply, stable, cattle, feed, dairy equipment, methods of milking and handling milk, transportation equipment and methods, sanitary conditions of city milk plants, of bottling works, of milk shops, and of milk wagons, and methods of caring for and handling milk in the homes. It will require the acceptance and enforcement of sanitary standards at every point where milk and dairy products are produced or handled; of a temperature standard so low that the few bacteria that will inevitably reach all milk shall have no opportunity to multiply; of a standard of bacterial content sufficiently low to exclude milk dangerous to health; and of a chemical standard so rigid as to prevent the sale of milk that is in any way adulterated or that is unduly low in nutritive value. The plan will doubtless require also that milk, ice-cream, butter and other dairy products be scientifically graded, according to quality; that they be so labeled as to indicate accurately their food value and degree of purity; and that prices be graded to agree with quality.

The program, furthermore, will call for an inspection service having adequate legal powers, effective supervision, and a staff of appropriate size and technical qualifications. The function of the inspection service will be not merely to ascertain facts for the purpose of locating defects and conducting prosecutions, but for the more important constructive purpose of educating producers, dealers and consumers as to the best methods for overcoming difficulties, for avoiding dangers, and for obtaining, with minimum cost and maximum satisfaction, a supply of milk that shall be safe and wholesome. The final and most effective factor in the program will be an informed, alert and exacting public, which will demand facts and discount unsupported opinions; which will insist that, day by day and hour by hour, such a record of work performed and results accomplished shall be kept by every producer, distributor and inspector of milk as will fix responsibility for results; and which will mete out, with even-handed justice, the appropriate reward of fidelity or dishonesty, efficiency or incompetence.

Hardly more than a beginning has been made in this country toward the development of such a program. A few States have

made some provision for dairy inspection, but this is generally limited to the examination of herds for diseased cattle, with occasional attempts at sanitary inspection of dairy farms. The State service is so inadequate that most large cities find it necessary to maintain their own inspection service. The reasonable division of functions would appear to be for the States to assume responsibility for conditions on the dairy farms, and the cities to control conditions incident to the distribution of milk within their own borders. This would avoid the duplication of inspection by cities drawing their supplies from the same territory and would make it impossible for a dairyman, when his milk is excluded from one city, to proceed at once to market his product in another city whose standards are less stringent or less rigorously enforced. Local and state regulation is to some extent supplemented by federal inspection of milk and other dairy products entering into interstate commerce. An extension and strengthening of the federal service would do much to improve the milk of a number of large cities which draw upon neighboring States for their supply.

In view of the numerous difficulties involved and the delays likely to attend a completely satisfactory solution of the milk problem, many persons are concerning themselves chiefly with expedients for solving at once certain of the difficulties and for reducing so far as possible the ill effects of milk produced under existing conditions. Temperature standards of 60 degrees Fahrenheit, or lower, have been established in some cities, with a view to preventing the rapid growth of bacteria and thus reducing the danger of serious infection. With similar purpose, standards have been adopted which exclude milk showing a bacterial count exceeding 100,000, 500,000 or 1,000,000 per cubic centimeter. Standards of 11.5, 12 or 13 per cent. of milk solids and 3 to 3.5 per cent. of butter fat have somewhat generally been established as a means of preventing adulteration. Infant milk stations, under both public and private management, have been established for the purpose of supplying clean milk either in its natural state or sterilized and specially modified to meet the requirements of infants of various ages. A model municipal dairy farm has been operated by at least one city for the purpose of setting a high standard for private dairymen. Complete

municipal ownership and operation of the dairy industry have been advocated, but not yet realized; while the commissioner of health of Chicago advocates the novel plan of bringing into the cities a sufficient number of cows to supply all artificially fed infants with milk less than twelve hours old at the time it is consumed, and of making it legally obligatory to use only such milk for the feeding of babies.

Most important of the proposed expedients is pasteurization, which, in its most approved form, consists in the heating of milk to a temperature of 140 degrees Fahrenheit, maintaining this temperature for twenty minutes, and then reducing the temperature rapidly to 50 degrees Fahrenheit. This process, it has been determined, will kill most pathogenic bacteria found in milk, including the bacilli causing typhoid, diphtheria and enteritis. The conclusion seems warranted also that careful pasteurization does not greatly, if at all, impair the general nutritive value of milk. The effect of pasteurization upon the various soluble ferments contained in milk is still doubtful, though it has been found that a temperature only slightly above 140 degrees Fahrenheit will weaken or destroy the activity of some of them. The functions of the ferments themselves are not fully understood, though they are probably related in a subtle way to the digestive requirements of the new-born. If, as seems likely, the specific character of the ferments accounts in great measure for the advantage of maternal over artificial feeding, the importance of more exact knowledge concerning the way in which they are affected by various temperatures and periods of heating is evident.

Even the advocates of pasteurization generally regard the process only as a valuable protective measure that may lessen the injurious effects of stale, warm, dirty and infected milk, but should not be permitted to interfere with efforts to promote care and cleanliness in every possible way in the production and handling of milk. Pasteurization certainly does not in any way improve the food value of milk and, by impairing the activity of certain ferments, may seriously affect its adaptation to very young infants. It destroys the acid-forming bacteria of milk and interferes with one of the surest evidences by which stale milk may be recognized, allowing certain putrefactive processes of dangerous character to continue without the restraining in-

fluences exerted by the lactic acid organisms in raw milk, and without the knowledge of the consumer. Certain poisonous bacterial products, furthermore, are not destroyed by pasteurization. It will be seen, therefore, that the practice of pasteurization is not to be considered too favorably, nor accepted as a final solution of the problem of safe milk, and that, in the interest of public health, it must be closely supervised by the proper authorities.

The problem of clean milk is to be solved, not by uninformed discussion, nor by the emotional clamor of indignant consumers, nor by the good intentions of producers, dealers, or public officials, nor by unenforced legal provisions. It is to be solved, as all other important problems of social welfare are to be solved, by scientific inquiry as to the facts involved; by the intelligent formulation of a comprehensive program for constructive work; by efficient co-operation on the part of producers, transportation companies, dealers, housewives, health officials, private social agencies; and by an informed, active and exacting citizenship.